C400 1.8-Inch SATA NAND Flash SED SSD

MTFDDAA128MAM-1Jx2, MTFDDAA256MAM-1Kx2, MTFDDAA512MAM-1Kx2

Features

- Micron® 25nm MLC NAND Flash
- RoHS-compliant package
- SATA 6 Gb/s interface
- TCG/Opal-compliant self-encrypting drive (SED)
- FIPS-certified, hardware-based AES-256 encryption engine
- ATA modes supported
  - PIO mode 3, 4
  - Multiword DMA mode 0, 1, 2
  - Ultra DMA mode 0, 1, 2, 3, 4, 5
- Industry-standard, 512-byte sector size support
- Hot-plug capable
- Native command queuing support with 32-command slot support
- ATA-8 ACS2 command set compliant
- ATA security feature command set and password login support (when TCG/Opal is not enabled)
- Secure erase (data page) command set: fast and secure erase
- TCG/Opal cryptographic erase, complete and secure in under 4 seconds
- Self-monitoring, analysis, and reporting technology (SMART) command set
- Performance[1, 2]
  - Sequential 128k READ: up to 500 MB/s
  - Sequential 128k WRITE: up to 260 MB/s
  - Random 4k READ: up to 45,000 IOPS
  - Random 4k WRITE: up to 50,000 IOPS
  - PCMark® Vantage (HDD test suite score): up to 75,000
  - READ/WRITE latency: 55µs (TYP)
- Reliability
  - MTBF: 1.2 million device hours[3]
  - Static and dynamic wear leveling
  - Uncorrectable bit error rate (UBER): <1 sector per 10^{15} bits read
- Low power consumption
  - <280mW TYP[4]
- Endurance: Total bytes written (TBW) – 72TB
- Capacity[5] (unformatted): 128GB, 256GB, 512GB
- Mechanical – 5mm height
  - Micro SATA connector: 3.3V ±5%
  - 1.8-inch drive: 78.5mm x 54mm x 5mm
  - Weight: 45g (MAX)
- Field-updateable firmware
- Operating temperature
  - Commercial (0°C to +70°C)[6]

Notes:
1. Typical I/O performance numbers as measured using Iometer with a queue depth of 32 and write cache enabled.
2. 4K transfers used for READ/WRITE latency values.
3. The product achieves a mean time between failure (MTBF) based on population statistics not relevant to individual units.
4. Active power measured during execution of MobileMark® 2007 with DIPM (device-initiated power management) enabled.
5. 1GB = 1 billion bytes; formatted capacity is less.
6. Drive case temperature.

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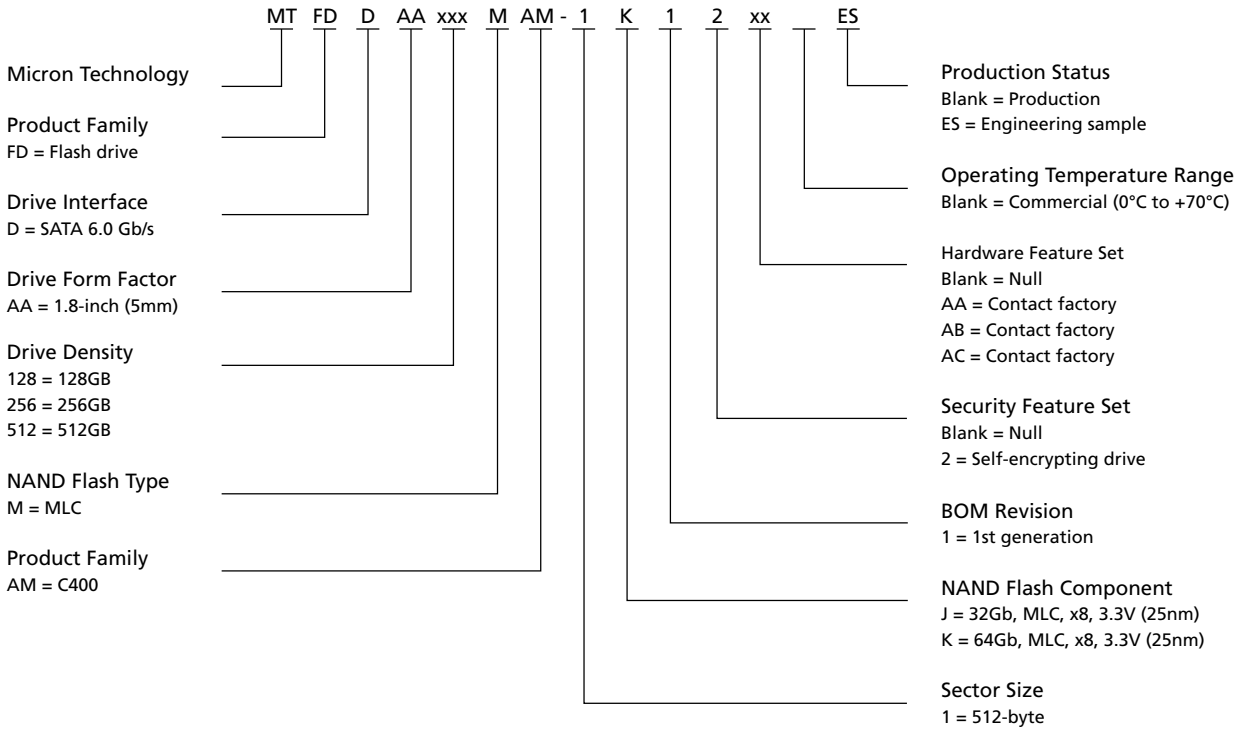
Part Numbering Information

Micron's RealSSD™ C400 SSD is available in different configurations and densities. Visit www.micron.com for a list of valid part numbers.

Figure 1: Part Number Chart



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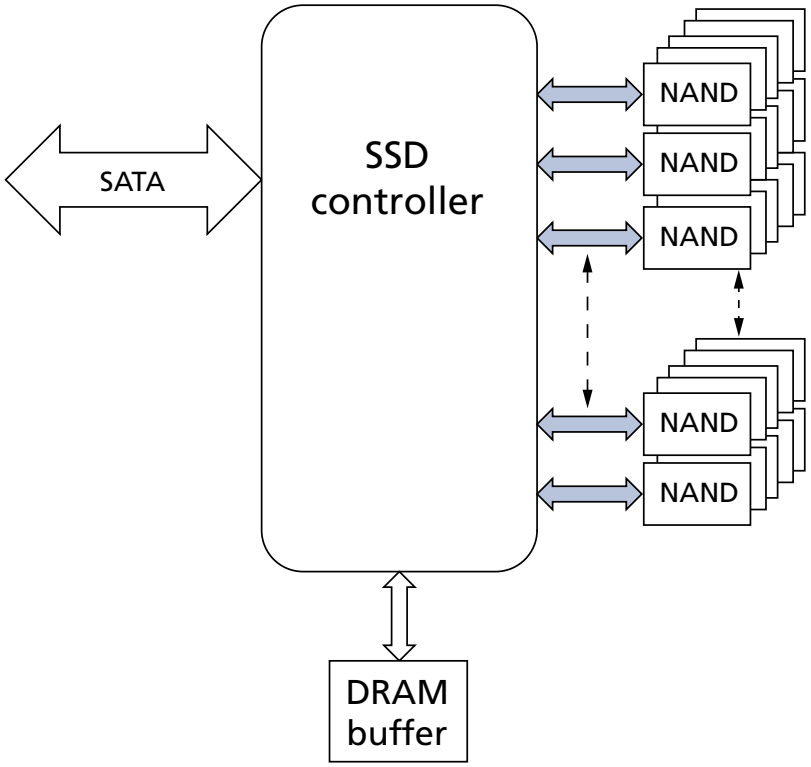
General Description

Micron's RealSSD solid state drive (SSD) uses a single-chip controller with a SATA interface on the system side and n-channels of Micron NAND Flash internally. Packaged in an HDD replacement enclosure, the SSD integrates easily in existing storage infrastructures.

The SSD is designed to use the SATA interface efficiently during both READs and WRITEs while delivering bandwidth-focused performance. SSD technology enables enhanced boot times, faster application load times, reduced power consumption, and extended reliability.

The RealSSD self-encypting drive (SED) features a FIPS-compliant AES-256 encryption engine, providing hardware-based, secure data encryption, with no loss of SSD performance. This SED follows the TCG/Opal specification for trusted peripherals.

Figure 2: Functional Block Diagram



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Logical Block Address Configuration

The drive is set to report the number of logical block addresses (LBA) that will ensure sufficient storage space for the specified density. Standard LBA settings, based on the IDEMA standard (LBA1-02), are shown below.

Table 1: Standard LBA Settings

Drive Size	Total LBA		Max LBA		User Available Bytes
	Decimal	Hexadecimal	Decimal	Hexadecimal	(Unformatted)
128GB	250,069,680	EE7C2B0	250,069,679	EE7C2AF	128,035,676,160
256GB	500,118,192	1DCF32B0	500,118,191	1DCF32AF	256,186,209,271
512GB	1,000,215,216	3B9E12B0	1,000,215,215	3B9E12AF	512,110,190,592

Physical Configuration

Table 2: 1.8-Inch Dimensions and Weight

	Value	Unit
Height	5	mm (NOM)
Width	54	mm (NOM)
Length	78.5	mm (NOM)
Unit weight	45	g (MAX)

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Interface Connectors

The SATA signal segment interface cable has four conductors and three ground connections. As shown in Package Dimensions, the cable includes a 7-pin signal segment and a 9-pin power segment arranged in a single row with a 1.27mm (0.050in) pitch.

Table 3: SATA Signal Segment Pin Assignments

Signal Name	Type	Description
S1	GND	Ground
S2	A	Differential signal pair A and A#
S3	A#	
S4	GND	Ground
S5	B#	Differential signal pair B and B#
S6	B	
S7	GND	Ground

Table 4: 1.8-Inch SATA Power Segment Pin Assignments

Pin#	Signal Name	Description
P1	V33	3.3V power
P2	V33	3.3V power
P3	GND	Ground
P4	GND	Ground
P5	V5	No connect
P6	V5	No connect
P7	Reserved	No connect
Key	Key	Key
P8	Optional	No connect
P9	Optional	No connect

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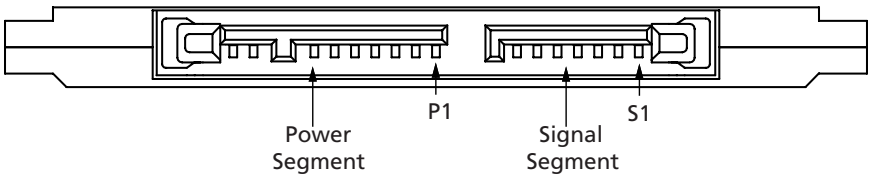
Figure 3: SSD Interface Connections



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Performance

Measured performance can vary for a number of reasons. The major factors affecting drive performance are the density of the drive and the interface of the host. Additionally, overall system performance can affect the measured drive performance. When comparing drives, it is recommended that all system variables are the same, and only the drive being tested varies.

Performance numbers will vary depending on the host system configuration.

Table 5: Drive Performance

Density	128GB	256GB	512GB	
Interface Speed	**6 Gb/s**	**6 Gb/s**	**6 Gb/s**	**Unit**
Sequential read (128k transfer)	500	500	500	MB/s
Sequential write (128k transfer)	175	260	260	MB/s
Random read (4k transfer)	45K	45K	45K	IOPs
Random write (4k transfer)	35K	50K	50K	IOPs
Read latency	55	55	55	µs
Write latency	55	55	55	µs
PCMark vantage	65K	75K	75K	HDD score

Notes:
1. Typical I/O performance numbers as measured using IOMeter with a queue depth of 32 and write cache enabled.
2. IOMeter measurements are performed on an 8GB span.
3. 4k transfers used for READ/WRITE latency values.
4. System variations may affect measured results.
5. Performance numbers are indicative of C400 firmware version 0009 and newer.

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Reliability

Micron's SSDs incorporate advanced technology for defect and error management. They use various combinations of hardware-based error correction algorithms and firmware-based static and dynamic wear-leveling algorithms.

Over the life of the SSD, uncorrectable errors may occur. An uncorrectable error is defined as data that is reported as successfully programmed to the SSD but when it is read out of the SSD, the data differs from what was programmed.

Table 6: Uncorrectable Bit Error Rate

Uncorrectable Bit Error Rate	Operation
<1 sector per 10^{15} bits read	READ

Mean Time Between Failures

Mean time between failures (MTBFs) for the SSD can be predicted based on the component reliability data using the methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment.

Table 7: MTBFs

Density	MTBF (Operating Hours)[1]
128GB	1.2 million
256GB	1.2 million
512GB	1.2 million

Note: 1. The product achieves a mean time between failure (MTBF) of 1.2 million hours, based on population statistics not relevant to individual units.

Endurance

Endurance for the SSD can be predicted based on the usage conditions applied to the device, the internal NAND component cycles, the write amplification factor, and the wear-leveling efficiency of the drive. The table below shows the drive lifetime for each SSD density based on predefined usage conditions.

Table 8: Drive Lifetime

Density	Drive Lifetime (Total Bytes Written)
128GB	72TB
256GB	72TB
512GB	72TB

Notes:
1. Total bytes written calculated with the drive 90% full.
2. Access patterns are 50% sequential and 50% random and consist of the following: 5% are 4k; 5% are 8k; 10% are 16k; 10% are 32k; 35% are 64K; and 35% are 128k.
3. GB/day can be calculated by dividing the total bytes written value by (365 × number of years). For example: 72TB/5 years/365 days = 40 GB/day for 5 years.

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Electrical Characteristics

Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Table 9: SATA Power Consumption

Density	Idle Average	Active Average	Sequential Write/Read Maximum (128k transfer)		Unit
128GB	<85	150	3500	2000	mW
256GB	<85	160	4000	2200	mW
512GB	<100	280	5500	2500	mW

Notes:
1. Data taken at 25°C using a 6 Gb/s SATA interface.
2. Active average power measured while running MobileMark® 2007 Productivity Suite.
3. DIPM (device-initiated power management) enabled.
4. Sequential power measured in IOMETER MAX with 128KB transfer size.

Table 10: Maximum Ratings

Parameter/Condition	Symbol	Min	Max	Unit
Voltage input	V33	3.14	3.46	V
Operating temperature	T_C	0	70	°C
Non-operating temperature		–40	85	°C
Rate of temperature change		–	20	°C/hour
Relative humidity (non-condensing)		5	95	%

Note:
1. Temperature is best measured with a thermocouple attached to the center point of the exterior of the case on the cast side where the SATA connector is **not** visible). Contact with the drive label is acceptable.

Table 11: Shock and Vibration

Parameter/Condition	Specification
Operating shock	1500 G/1.0ms
Operating vibration	2–500Hz at 3.1G

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Table 12: TCG/Opal Support Parameters

TCG Property	Requirement	Min Requirement in TCG/Opal	Micron C400 Implementation	Remarks
COM ID management support	Vendor decision		Not supported	Dynamic COM ID allocation and management
Base COM ID	Vendor decision		0x1000	0x1000-0xFFFF defined for COM ID management
Number of COM IDs		1	1	
Buffer management support	Vendor decision		No	Flow control
ACK/NACK support	Vendor decision		No	Session reliability
Async support	Vendor decision		No	Asynchronous protocol support with multiple commands per session
Range crossing	Vendor decision		0	If the drive receives a READ or WRITE command that spans multiple LBA ranges and the LBA ranges are not locked, then: 1. Process the data transfer if range crossing = 0 2. Terminate the command with "Other Invalid Command Parameter" if range crossing = 1
Protocol stack reset	Optional		Yes	
MaxComPacketSize		2048	16,384	Host value accepted is VU for maximum
MaxResponseComPacketSize		2048	16,384	
MaxPacketSize		2028	16,064	Host value accepted is VU for maximum
MaxIndTokenSize		1992	15,488	Host value accepted is VU for maximum
MaxPackets		1	1	Host value accepted is VU for maximum
MaxSubPackets		1	1	Host value accepted is VU for maximum
MaxSessions		1	1	Each session requires a set of buffers and variables
MaxTransactionLimit		1	1	Transaction are inside sessions
MaxMethods		1	1	Methods are contained in a transaction
MaxAuthentications		2	2	
DefSessionTimeout	Vendor decision		Yes	
Close session	Optional		Yes	Enables the trusted device to notify the host that it has aborted a session
Interface control template (restricted commands table)	Optional		No	The interface control template enables trusted device control over selected interface commands. The benefit is the reduction of undesired side effects.
Type table	Not required		No	

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Table 12: TCG/Opal Support Parameters (Continued)

TCG Property	Requirement	Min Requirement in TCG/Opal	Micron C400 Implementation	Remarks
AES key size	128/256 bits		256 bits	AES key is generated by the using CTR DRBG algorithm (FIPS-compliant)
# LBA ranges		4	16	Supports up to 16 LBA ranges and the same AES key is used for all ranges. Cross-range READ and WRITE operations are supported if LBA ranges are unlocked.
# Admins		1	16	
# Users		4	16	
MBR table		128MB	128MB	
Datastore table		1KB	10MB	
Re-encryption			No	
Secure firmware download				Secure firmware download feature is optional. The firmware image is validated by using the SHA256 and RSA2048 algorithms (FIPS-compliant)

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Device ID

Table 13: Identity Device

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
0				General configuration bit-significant information
	15	F	0b	0 = ATA device
	14–8	X	0000100b	Retired
	7	F	0b	1 = removable media device
	6	F	1b	Obsolete
	5–3	X	000b	Retired
	2	V	0b	Response incomplete
	1	X	0b	Retired
	0	F	0b	Reserved
1			3FFFh	Obsolete
2		F	C837h	Specific configuration
3		F	0010h	Obsolete
4		F	0000h 0000h	Retired
6		F	003Fh	Obsolete
7		(O)V	0000h 0000h	Reserved for assignment by the CompactFlash™ Association
9		( )X	0000h	Retired
10		(M)F	varies	Serial number (20 ASCII characters)
20		( )X	0000h 0000h 0000h	Retired/Obsolete
23		(M)F	varies	Firmware revision (8 ASCII characters)
27		(M)F	varies	Model number (40 ASCII characters)
47	15–8	F	80h	80h
	7–0	F	10h	00h = Reserved 01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands
48				Trusted Computing feature set options
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13–1	F	0000000000000b	Reserved for the Trusted Computing Group
	0	F	1b	1=Trusted Computing feature set is support

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
49				Capabilities
	15–14	F	00b	Reserved for the IDENTIFY PACKET DEVICE command.
	13	F	1b	1 = Standby timer values as specified in this standard are supported
				0 = Standby timer values shall be managed by the device
	12	F	0b	Reserved for the IDENTIFY PACKET DEVICE command.
	11	F	1b	1= IORDY supported
				0 = IORDY may be supported
	10	F	1b	1 = IORDY may be disabled
	9		1b	1 = LBA supported
	8	F	1b	1 = DMA supported.
	7–0	F	00000000b	Retired
50				Capabilities
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13–2	F	000000000000b	Reserved
	1	X	0b	Obsolete
	0	F	1b	Shall be set to one to indicate a vendor specific standby timer value minimum.
51		( )X	0000h 0000h	Obsolete
53	15–3	F	0000000000000b	Reserved
	2	F	1b	1 = the fields reported in word 88 are valid 0 = the fields reported in word 88 are not valid
	1	F	1b	1 = the fields reported in words (70:64) are valid 0 = the fields reported in words (70:64) are not valid
	0	X	1b	Obsolete
54		()X	3FFFh 0010h 003Fh FC10h 00FBh	Obsolete
59	15	F	0b	1 = The BLOCK ERASE EXT command is supported
	14	F	0b	1 = The OVERWRITE EXT command is supported
	13	F	0b	1 = The CRYPTO SCRAMBLE EXT command is supported
	12	F	0b	1 = The Sanitize feature set is supported
	11–9	F	000b	Reserved
	8	V	1b	1 = Multiple sector setting is valid
	7–0	V	00000001b	xxh = Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands
60		M(F)	Varies by capacity	Total number of user addressable logical sectors

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
62		()X	0000h	Obsolete
63	15–11	F	00000b	Reserved
	10	V	0b	1 = Multiword DMA mode 2 is selected 0 = Multiword DMA mode 2 is not selected
	9	V	0b	1 = Multiword DMA mode 1 is selected 0 = Multiword DMA mode 1 is not selected
	8	V	0b	1 = Multiword DMA mode 0 is selected 0 = Multiword DMA mode 0 is not selected
	7–3	F	0000b	Reserved
	2	F	1b	1 = Multiword DMA mode 2 and below are supported
	1	F	1b	1 = Multiword DMA mode 1 and below are supported
	0	F	1b	1 = Multiword DMA mode 0 is supported
64	15–8	F	0	Reserved
	7–0	F	03h	PIO modes supported
65		F	0078h	Minimum Multiword DMA transfer cycle time per word Cycle time in nanoseconds
66		F	0078h	Manufacturer's recommended Multiword DMA transfer cycle time Cycle time in nanoseconds
67		F	0078h	Minimum PIO transfer cycle time without flow control Cycle time in nanoseconds
68		F	0078h	Minimum PIO transfer cycle time with IORDY flow control Cycle time in nanoseconds
69		F		Additional Supported
	15	F	0b	1 = CFast Specification Support
	14	F	1b	1 = Deterministic read after Trim is supported
	13	F	0b	1 = Long Physical Sector Alignment Error Reporting Control is supported
	12	F	0b	1 = DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported
	11	F	0b	1 = READ BUFFER DMA is supported
	10	F	0b	1 = WRITE BUFFER DMA is supported
	9	F	0b	1 = SET MAX PASSWORD DMA and SET MAX UNLOCK DMA are supported
	8	F	0b	1 = DOWNLOAD MICROCODE DMA is supported
	7	F	0b	Reserved for IEEE-1667
	6	F	0b	1 = Optional ATA device 28-bit commands supported
	5	F	0b	1 = Read zero after Trim is supported
	4–0	F	00000b	Reserved
70		F	0000h	Reserved

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
71		F	0000h 0000h 0000h 0000h	Reserved for the IDENTIFY PACKET DEVICE command
75				Queue depth
	15–5	F	00000000000b	Reserved
	4–0	F	11111b	Maximum queue depth - 1
76				Serial ATA Capabilities
	15–13	F	000b	Reserved
	12	F	1b	Supports Native Command Queuing priority information
	11	F	0b	Supports Unload while NCQ commands outstanding
	10	F	1b	Supports Phy event counters
	9	F	1b	Supports receipt of host initiated interface power management requests
	8	F	1b	Supports native Command Queueing
	7–4	F	0000b	Reserved for future Serial ATA signaling speed grades
	3	F	1b	1 = Supports Serial ATA Gen-3 speed (6.0 Gb/s)
	2	F	1b	1 = Supports Serial ATA Gen-2 speed (3.0 Gb/s)
	1	F	1b	1 = Supports Serial ATA Gen-1 speed (1.5 Gb/s)
	0	F	0b	Reserved (set to 0)
77				Serial ATA Additional capabilities
	15–6	F	0000000000b	Reserved for future Serial ATA definition
	5	F	0b	Supports NCQ Queue Management Command
	4	F	0b	Supports NCQ Streaming
	3–1	V	010b	Coded value indicating current negotiated Serial ATA signal speed
	0	F	0b	Shall be cleared to zero
78				Serial ATA features Supported
	15–7	F	000000000b	Reserved
	6	F	1b	1 = supports software settings preservation
	5	F	0b	Reserved
	4	F	0b	1 = supports in-order data delivery
	3	F	1b	1 = supports dev initiate interface power management
	2	F	1b	1 = supports DMA Setup Auto-Activate optimization
	1	F	0b	1 = supports non-zero buffer offsets in DMA Setup FIS
	0	F	0b	Reserved (set to 0)

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
79				Serial ATA features Enabled
	15–7	V	000000000b	Reserved
	6	V	1b	1 = software settings preservation enabled
	5	V	0b	1 = Asynchronous notification enabled
	4	V	0b	1 = in-order data delivery enabled
	3	V	0b	1 = device initiating interface power management enabled
	2	V	0b	1 = DMA Setup Auto-Activate optimization enabled
	1	V	0b	1 = non-zero buffer offsets in DMA Setup FIS enabled
	0	V	0b	Reserved (set to 0)
80				Major revision number
	15–10	F	000000b	Reserved
	9	F	1b	1 = supports ATA8-ACS2
	8	F	1b	1 = supports ATA8-ACS
	7	F	1b	1 = supports ATA/ATAPI-7
	6	F	1b	1 = supports ATA/ATAPI-6
	5	F	1b	1 = supports ATA/ATAPI-5
	4	F	1b	1 = supports ATA/ATAPI-4
	3	F	1b	Obsolete
	2	S	0b	Obsolete
	1	S	0b	Obsolete
	0	F	0b	Reserved
81		F	0028h	Minor revision number
				0028h = ATA8-ACS version 6

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
82				Command set supported
	15	X	0b	Obsolete
	14	F	1b	1 = NOP command supported
	13	F	1b	1 = READ BUFFER command supported
	12	F	1b	1 = WRITE BUFFER command supported
	11	X	0b	Obsolete
	10	F	1b	1 = Host Protected Area feature set supported
	9	F	0b	1 = DEVICE RESET command supported
	8	F	0b	1 = SERVICE interrupt supported
	7	F	0b	1 = release interrupt supported
	6	F	1b	1 = read look-ahead supported
	5	F	1b	1 = write cache supported
	4	F	0b	Shall be cleared to zero to indicate that the PACKET feature set is not supported.
	3	F	1b	1 = mandatory Power Management feature set supported
	2	F	0b	Obsolete
	1	F	1b	1 = Security feature set supported
	0	F	1b	1 = SMART feature set supported
83				Command set supported
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13	F	1b	1 = FLUSH CACHE EXT command supported
	12	F	1b	1 = mandatory FLUSH CACHE command supported
	11	F	1b	1 = Device Configuration Overlay feature set supported
	10	F	1b	1 = 48-bit Address feature set supported
	9	F	0b	1 = Automatic Acoustic Management feature set supported
	8	F	1b	1 = SET MAX security extension supported
	7	F	0b	See Address Offset Reserved Area Boot INCITS TR27:2001
	6	F	0b	1 = SET FEATURES subcommand required to spin-up after power-up
	5	F	0b	1 = Power-Up In Standby feature set supported
	4	F	0b	Obsolete
	3	F	1b	1 = Advanced Power Management feature set supported
	2	F	0b	1 = CFA feature set supported
	1	F	0b	1 = READ/WRITE DMA QUEUED supported
	0	F	1b	1 = DOWNLOAD MICROCODE command supported

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
84				Command set/feature supported extension
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13	F	1b	1 = IDLE IMMEDIATE with UNLOAD FEATURE supported
	12	F	0b	Reserved for technical report INCITS TR-37-2004 (TLC)
	11	F	0b	Reserved for technical report INCITS TR-37-2004 (TLC)
	10–9	F	00b	Obsolete
	8	F	1b	1 = 64-bit Word wide name supported
	7	F	0b	1 = WRITE DMA QUEUED FUA EXT command supported
	6	F	1b	1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported
	5	F	1b	1 = General Purpose Logging feature set supported
	4	F	0b	1 = Streaming feature set supported
	3	F	0b	1 = Media Card Pass Through Command feature set supported
	2	F	0b	1 = Media serial number supported
	1	F	1b	1 = SMART self-test supported
	0	F	1b	1 = SMART error logging supported
85				Command set/feature enabled.
	15	X	0b	Obsolete
	14	F	1b	1 = NOP command supported
	13	F	1b	1 = READ BUFFER command supported
	12	F	1b	1 = WRITE BUFFER command supported
	11	X	0b	Obsolete
	10	V	1b	1 = Host Protected Area feature set enabled
	9	F	0b	1 = DEVICE RESET command supported
	8	V	0b	1 = SERVICE interrupt enabled
	7	V	0b	1 = release interrupt enabled
	6	V	1b	1 = look-ahead enabled
	5	V	1b	1 = write cache enabled
	4	F	0b	Shall be cleared to zero to indicate that the PACKET feature set is not supported.
	3	F	1b	Power Management feature set is enabled
	2	F	0b	Obsolete
	1	V	0b	1 = Security Mode feature set enabled
	0	V	1b	1 = SMART feature set enabled

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
86				Command set/feature enabled.
	15		1b	1 = Words 120-119 are valid
	14	F	0b	1 = Reserved
	13	F	1b	1 = FLUSH CACHE EXT command supported
	12	F	1b	1 = FLUSH CACHE command supported
	11	F	1b	1 = Device Configuration Overlay supported
	10	F	1b	1 = 48-bit Address features set supported
	9	V	0b	1 = Automatic Acoustic Management feature set enabled
	8	F	0b	1 = SET MAX security enabled by SET MAX SET PASSWORD
	7	F	0b	Reserved for address Offset Reserved Area Boot, INCITS TR27:2001
	6	F	0b	1 = SET FEATURES subcommand required to spin-up after power-up
	5	V	0b	1 = Power-Up In Standby feature set enabled
	4	V	0b	Obsolete
	3	V	1b	1 = Advanced Power Management feature set enabled
	2	F	0b	1 = CFA feature set supported
	1	F	0b	1 = READ/WRITE DMA QUEUED command supported
	0	F	1b	1 = DOWNLOAD MICROCODE command supported
87				Command set/feature enabled/supported
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13	F	1b	1 = IDLE IMMEDIATE with UNLOAD FEATURE supported
	12	V	0b	Reserved for technical report- INCITS tr-37-2004 (TLC)
	11	V	0b	Reserved for technical report- INCITS TR-37-2004 (TLC)
	10–9	F	00b	Obsolete
	8	F	1b	1 = 64-bit Word wide name supported
	7	F	0b	1 = WRITE DMA QUEUED FUA EXT command supported
	6	F	1b	1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported
	5	F	1b	1 = General Purpose Logging feature set supported
	4	V	0b	Obsolete
	3	V	0b	1 = Media Card Pass Through Command feature set supported
	2	V	0b	1 = Media serial number is valid
	1	F	1b	1 = SMART self-test supported
	0	F	1b	1 = SMART error logging supported

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
88			0b	Ultra DMA modes
	15		0b	Reserved
	14		0b	1 = Ultra DMA mode 6 is selected 0 = Ultra DMA mode 6 is not selected
	13		0b	1 = Ultra DMA mode 5 is selected 0 = Ultra DMA mode 5 is not selected
	12		0b	1 = Ultra DMA mode 4 is selected 0 = Ultra DMA mode 4 is not selected
	11		0b	1 = Ultra DMA mode 3 is selected 0 = Ultra DMA mode 3 is not selected
	10		0b	1 = Ultra DMA mode 2 is selected 0 = Ultra DMA mode 2 is not selected
	9		0b	1 = Ultra DMA mode 1 is selected 0 = Ultra DMA mode 1 is not selected
	8		0b	1 = Ultra DMA mode 0 is selected 0 = Ultra DMA mode 0 is not selected
	7		0b	Reserved
	6		0b	1 = Ultra DMA mode 6 and below are supported
	5		1b	1 = Ultra DMA mode 5 and below are supported
	4		1b	1 = Ultra DMA mode 4 and below are supported
	3		1b	1 = Ultra DMA mode 3 and below are supported
	2		1b	1 = Ultra DMA mode 2 and below are supported
	1		1b	1 = Ultra DMA mode 1 and below are supported
	0		1b	1 = Ultra DMA mode 0 IS supported
89		(O)F	0001h	Time required for security erase unit completion
90		(O)F	0001h	Time required for Enhanced security erase completion
91		(O)V	00FEh	Current advanced power management value
92		(O)V	FFFEh	Master Password Revision Code

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
93				Shall be 0000h for SATA devices
	15		0b	Shall be cleared to zero
	14		0b	Shall be set to one
	13		0b	1 = device detected CBLID-above V_{IH} 0 = device detected CBLID-below V_{IL}
				Device 1 hardware reset result Device 0 shall clear these bits to zero Device 1 shall set these bits as follows:
	12		0b	Reserved
	11		0b	0 = Device 1 did not assert PDIAG- 1 = Device 1 asserted PDIAG-
	10–9			These bits indicate how Device 1 determined the device number: 00 = Reserved 01 = a jumper was used 10 = the CSEL signal was used 11 = some other method was used or the method is unknown
	8		0b	Shall be set to one
				Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
	7		0b	Reserved
	6		0b	0 = Device 0 does not respond when Device 1 is selected. 1 = Device 0 responds when Device 1 is selected.
	5		0b	0 = Device 0 did not detect the assertion of DASP- 1 = Device 0 detected the assertion of DASP-
	4		0b	0 = Device 0 did not detect the assertion of PDIAG- 1 = Device 0 detected the assertion of PDIAG-
	3		0b	0 = Device 0 failed diagnostics. 1 = Device 0 passed diagnostics.
	2–1		00b	These bits indicate how Device 0 determined the device number: 00 = Reserved 01 = a jumper was used 10 = the CSEL signal was used 11 = some other method was used or the method is unknown
	0		0b	Shall be set to one
94	15–8	F	00h	Vendor's recommended acoustic management value
	7–0	V	00h	Current automatic acoustic management value
95		(O)V	0000h	Stream Minimum Request Size

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
96		(O)V	0000h	Streaming Transfer Time - DMA
97		(O)V	0000h	Streaming Access Latency - DMA and PIO
98		(O)F	0000h 0000h	Streaming Performance Granularity(98-99)
100		V	Varies by capacity	Maximum user LBA for 48-bit Address feature set
104		(O)V	0000h	Streaming Transfer Time - PIO
105		( )F	0008h	Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command
106				Physical sector size / Logical Sector Size
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13	F	0b	1 = Device has multiple logical sectors per physical sector
	12	F	0b	1 = Device Logical Sector Longer than 256 Words
	11–4	F	00000000b	Reserved
	3–0	F	0000b	2^x logical sectors per physical sector
107		(O)F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108	15–12	F	0101b	NAA (3-0)
	11–0		000000001010b	IEEE OUI (23-12)
109	15–4	F	000001110101b	IEEE OUI (11-0)
	3–0		Varies	Unique ID (35-32)
110		(M)F	Varies	5-0 Unique ID (31-16)
111		(M)F	Varies	Unique ID (15-0)
112		(O)F	0000h 0000h 0000h 0000h	Reserved for 128 bit world wide name extension to 128 bits
116		(O)V	0000h	Reserved for INCITS TR-37-2004
117		(O)F	0000h 0000h	Words per Logical Sector

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
119				Commands and feature sets supported (Continued from words 84-82)
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13–6	F	00000001b	Reserved
	5	F	0b	1 = Free-fall Control feature set is supported
	4	F	1b	1 = The DOWNLOAD MICROCODE command with mode 3 is supported
	3	F	1b	1 = READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
	2	F	1b	1 = The Write-Read-Verify feature set is supported
	1	F	1b	1 = Feature set "Disable Data Transfer After Error Detection" is supported
	0	F	0b	Reserved for DDT
120				Commands and feature sets supported or enabled (Continued from words 87-85)
	15		0b	Shall be cleared to zero
	14		1b	Shall be set to one
	13–6		00000000b	Reserved
	5		0b	1 = Free-fall Control feature set is enabled
	4		1b	1 = The DOWNLOAD MICROCODE command with mode 3 is supported
	3		1b	1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
	2		1b	1 = The WRITE UNCORRECTABLE EXT command is supported
	1		0b	1 = The Write-Read-Verify feature set is enabled
	0		0b	1= Feature set "Disable Data Transfer After Error Detection" is enabled 0 = Feature set "Disable Data Transfer After Error Detection" is disabled
121		F	0000h 0000h 0000h 0000h 0000h 0000h	Reserved for expanded supported and enabled settings
127		(O)	0000h	Obsolete

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
128				Security status
	15–9	F	0000000b	Reserved
	8	V	0b	Security level 0 = High, 1 = Maximum
	7–6	F	00b	Reserved
	5	F	1b	1 = Enhanced security erase supported
	4	V	0b	1 = Security count expired
	3	V	0b	1 = Security frozen
	2	V	0b	1 = Security locked
	1	V	0b	1 = Security enabled
	0	F	1b	1 = Security supported
129		( )X	Vendor specific data	Vendor specific
160				CFA power mode 1
	15	F	0b	Word 160 supported
	14	F	0b	Reserved
	13	F	0b	CFA power mode 1 is required for one or more commands implemented by the device
	12	V	0b	CFA power mode 1 disabled
	11–0	F	000000000000b	Maximum current in ma
161		X	0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h	Reserved for assignment by the CompactFlash Association
168	15–4	F	000h	Reserved
	3-0	F	4h	Device nominal form factor
169				DATA SET MANAGEMENT command support
	15–1	F	000000000000000b	Reserved
	0	F	1b	1 = the Trim bit in the DATA SET MANAGEMENT command is supported
170		F	0000h 0000h 0000h 0000h	Additional Product Identifier
174		F	0000h 0000h	Reserved
176		(O)V	Varies	Current media serial number (60 ASCII characters)

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
206				SCT Command Transport
	15–12	X	0000b	Vendor Specific
	11–6	F	000000b	Reserved
	5	F	1b	SCT Command Transport Data Tables supported
	4	F	1b	CT Command Transport Features Control supported
	3	F	1b	SCT Command Transport Error Recovery Control supported
	2	F	1b	SCT Command Transport Write Same supported
	1	F	0b	SCT Command Transport Long Sector Access supported
	0	F	1b	SCT Command Transport supported
207		( )F	0000h 0000h	Reserved for CE-ATA
209		(O)		Alignment of logical blocks within a larger physical block
	15	F	0b	Shall be cleared to zero
	14	F	1b	Shall be set to one
	13–0	F	00000000000000b	'Logical sector' offset within the first physical sector where the first logical
				sector is placed.
210		(O)V	0000h 0000h	Write-Read-Verify Sector Count Mode 3 Only
212		(O)F	0000h 0001h	Verify Sector Count Mode 2 Only
214		(O)		NV Cache Capabilities
	15–12	F	0000b	NV Cache feature set version
	11–8	F	0000b	NV Cache Power Mode feature set version
	7–5	F	000b	Reserved
	4	V	0b	1 = NV Cache feature set enabled
	3–2	F	00b	Reserved
	1	V	0b	1 = NV Cache Power Mode feature set enabled
	0	F	0b	1 = NV Cache Power Mode feature set supported
215		(O)V	0000h	NV Cache Size in Logical Blocks (LSW)
216		(O)V	0000h	NV Cache Size in Logical Blocks (MSW)
217		(M)F	0001h	Nominal media rotation rate (ATA8-ACS 1699-D Revision 6)
				NV Cache Read Transfer Speed in MB/s (ATA8-ACS 1699-D Revision 3f)
218		(O)V	0000h	NV Cache Write Transfer Speed in MB/s
219				NV Cache Options
	15–8	F	00h	Reserved
	7–0	F	00h	Device Estimated Time to Spin Up in Seconds
220	15–8	F	00h	Reserved
	7–0	V	00h	Write-Read-Verify feature set current mode
221			0000h	Reserved

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Table 13: Identity Device (Continued)

See Note 1 for setting definitions

Word	Bit(s)	Setting	Default Value	Description
222				Transport Major revision number. 0000h or FFFFh = device does not report version
	15–12		0001b	Transport Type - 0 = Parallel, 1 = Serial, 2-15 = Reserved Parallel (Type = 0) Serial (Type = 1)
	11–6		000000b	Reserved Reserved
	5		1b	Reserved SATA Rev 3.0
	4		1b	Reserved SATA Rev 2.6
	3		1b	Reserved SATA Rev 2.5
	2		1b	Reserved SATA II: Extensions
	1		1b	Reserved SATA 1.0a
	0		1b	ATA8-APT ATA8-AST
223		(M)F	0000h	Transport Minor revision number
224		( )F	0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h	Reserved for CE-ATA
234		(O)F	0001h	Minimum number of 512 byte units per DOWNLOAD MICROCODE command for mode 3
235			00FFh	Maximum number of 512 byte units per DOWNLOAD MICROCODE command for mode 3
236			0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h 0000h	Reserved
255		(M)F		Integrity word
	15–8		varies	Checksum
	7–0		A5h	Signature

Note: 1. F = The content of the word is fixed and does not change.
V = The content of the word is variable and may change depending on the state of the device or the commands executed by the device.
X = The content of the word may be fixed or variable.
R = The content of the word is reserved and will be zero.

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Commands

Table 14: Supported ATA Command Set

See ATA-8 standard for command details

Command Name	Command Code (hex)
CHECK POWER MODE	98h or E5h
DEVICE CONFIGURATION RESTORE	B1h/C1h
DEVICE CONFIGURATION FREEZE LOCK	B1h/C3h
DEVICE CONFIGURATION IDENTIFY	B1h/C1h
DEVICE CONFIGURATION SET	B1h/C3h
DOWNLOAD MICROCODE	92h
EXECUTE DEVICE DIAGNOSTIC	90h
FLUSH CACHE	E7h
FLUSH CACHE EXT	EAh
IDENTIFY DEVICE	ECh
IDLE	E3h or 97h
IDLE IMMEDIATE	E1h or 95h
INITIALIZE DEVICE PARAMETERS	91h
NOP	00h
READ BUFFER	E4h
READ DMA (with retry)	C8h
READ DMA (without retry)	C9h
READ DMA EXT	25h
READ FPDMA QUEUED	60h
READ LOG EXT	2Fh
READ MULTIPLE	C4h
READ MULTIPLE EXT	29h
READ NATIVE MAX ADDRESS	F8h
READ NATIVE MAX ADDRESS EXT	27h
READ SECTOR(S) EXT	24h
READ SECTOR(S) (with retry)	20h
READ SECTOR(S) (without retry)	21h
READ VERIFY SECTOR EXT	42h
READ VERIFY SECTOR(S) (with retry)	40h
SCT WRITE SAME	02h/0001h 02h/0002h 02h/0101h 02h/0102h
SCT RETURN ERROR RECOVERY CONTROL	030h/01h
SCT SET ERROR RECOVERY CONTROL	03h/01h
SCT SET FEATURE CONTROL	04h/01h
SCT RETURN FEATURE CONTROL	04h/02h

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Table 14: Supported ATA Command Set (Continued)

See ATA-8 standard for command details

Command Name	Command Code (hex)
SCT RETURN FEATURE OPTION FLAG	04h/03h
SCT RETURN SCT DATA TABLE	05h/01h
SECURITY DISABLE PASSWORD	F6h
SECURITY ERASE PREPARE	F3h
SECURITY ERASE UNIT	F4h
SECURITY FREEZE LOCK	F5h
SECURITY SET PASSWORD	F1h
SECURITY UNLOCK	F2h
SEEK	7xh
SET FEATURES	EFh
SET MAX ADDRESS	F9h
SET MAX – FREEZE LOCK	F9h/04h
SET MAX – LOCK	F9h/02h
SET MAX ADDRESS EXT	37h
SET MULTIPLE MODE	C6h
SET MAX – SET PASSWORD	F9h/01h
SET MAX – UNLOCK	F9h/03h
SLEEP	E6h or 99h
SMART DISABLE OPERATIONS	B0h/D9h
SMART ENABLE OPERATIONS	B0h/D8h
SMART ENABLE/DISABLE AUTOSAVE	B0h/D2h
SMART EXECUTE OFF-LINE IMMEDIATE	B0h/D4h
SMART READ DATA	B0h/D0h
SMART READ LOG SECTOR	B0h/D5h
SMART RETURN STATUS	B0h/DAh
SMART WRITE LOG	B0h/D6h
STANDBY	E2h or 96h
STANDBY IMMEDIATE	E0h or 94h
TRUSTED NON-DATA	5Bh
TRUSTED RECEIVE	5Ch
TRUSTED RECEIVE DMA	5Dh
TRUSTED SEND	5Eh
TRUSTED SEND DMA	5Fh
WRITE BUFFER	E8h
WRITE DMA (with retry)	CAh
WRITE DMA (without retry)	CBh
WRITE DMA EXT	35h

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Table 14: Supported ATA Command Set (Continued)

See ATA-8 standard for command details

Command Name	Command Code (hex)
WRITE DMA FUA EXT	3Dh
WRITE FPDMA QUEUED	61h
WRITE LOG EXT	3Fh
WRITE MULTIPLE	C5h
WRITE MULTIPLE EXT	39h
WRITE MULTIPLE FUA EXT	CEh
WRITE SECTOR(S) (with retry)	30h
WRITE SECTOR(S) EXT	34h
WRITE UNCORRECTABLE EXT	45h

Compliance

Micron self-encrypting SSDs comply with the following:

- RoHS “green”
- CE (Europe): EN55022, 2006 Class B and EN55024, 1998 + A1: 2001 + A2:2003
- FCC: CFR Title 47, Part 15, ICES-003, all Class B
- UL (US): approval to UL-60950-1, 2nd Edition, 2007-03-27, IEC 60950-1:2005, 2nd Edition
- BSMI (Taiwan): approval to CNS 13438
- C-TICK (Australia, New Zealand): approval to AS/NZS CISPR22
- KCC RRL (Korea): approval to KCC MU2-C30025, KCC MU2-C30018 Class B
- W.E.E.E.: Compliance with EU WEEE directive 2002/96/EC. Additional obligations may apply to customers who place these products in the markets where WEEE is enforced.
- TUV (Germany): approval to IEC60950/EN60950
- V_{CCI}
- IC (Canada):
  - This Class B digital apparatus complies with Canadian ICES-003.
  - Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.
- Micron encryption algorithms have received the following NIST certifications:
  – Micron AES Module Cert. #1704
  – Micron DRBG Module Cert. #105
  – Micron RSA Module Cert. #833
  – Micron SHA 256 Module Cert. #1487
- Trusted Computing Group Storage Security Subsystem Class: Opal

FCC Rules

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and

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used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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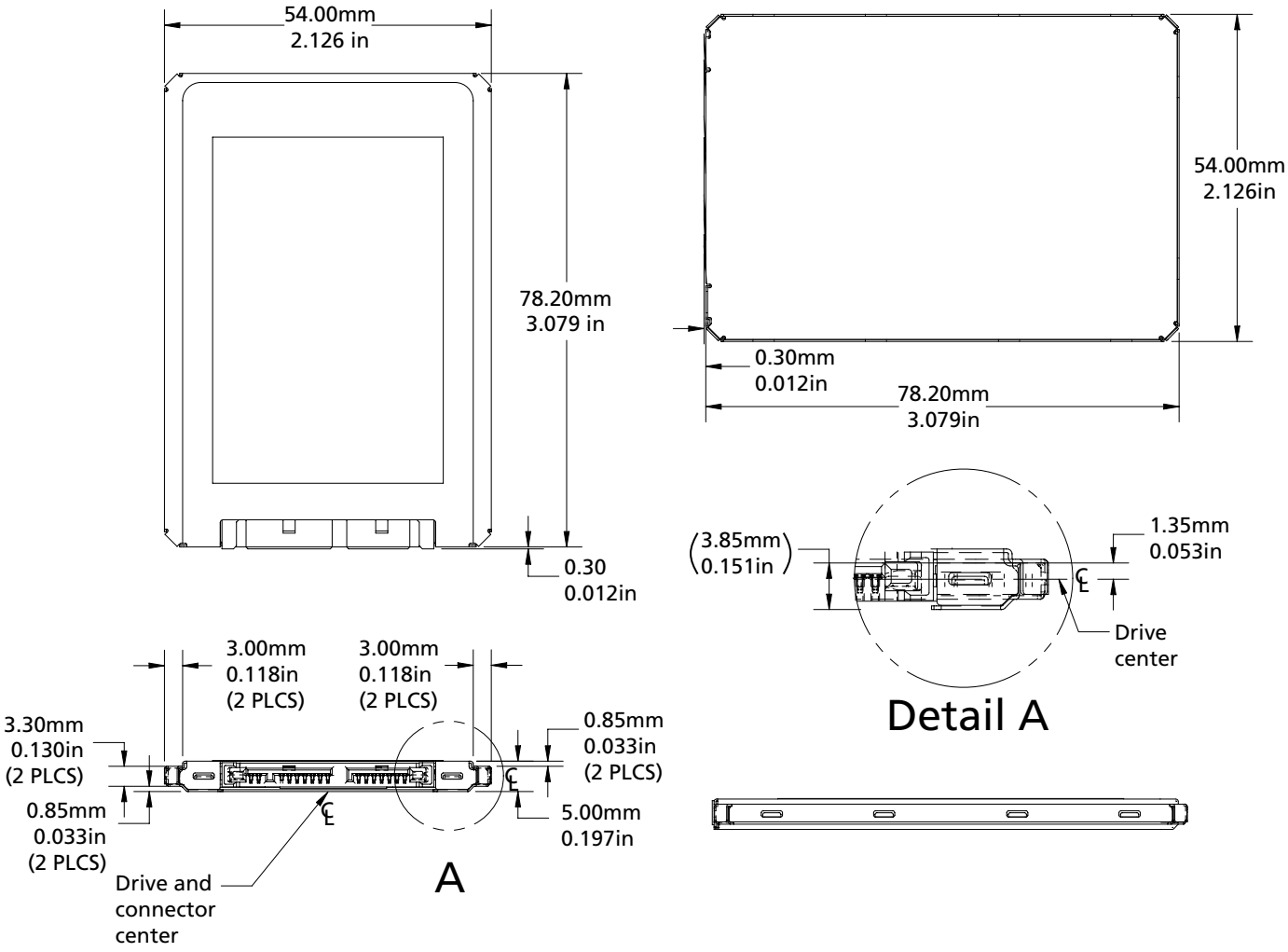
Package Dimensions

Figure 4: 1.8-Inch Package



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References

- Serial ATA: High-speed serialized AT attachment, Serial ATA working group, available at www.sata-io.org
- SATA 3.0 GOLD
- ATA-8 ACS2

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Revision History

Rev. A, Preliminary – 09/11

- Initial release

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